



VIRGINIA SOIL AND WATER CONSERVATION BOARD GUIDANCE DOCUMENT ON IMPOUNDING STRUCTURE HAZARD CLASSIFICATION PROCEDURES

(Approved September 7, 2016)

Summary:

This guidance document outlines the decision process to be utilized by the Virginia Soil and Water Conservation Board and an owner and his engineer in determining hazard potential classification of an impounding structure in accordance with the Dam Safety Act and the Virginia Impounding Structure Regulations.

Electronic Copy:

An electronic copy of this guidance in PDF format is available on the Regulatory Town Hall under the Virginia Soil and Water Conservation Board at <http://townhall.virginia.gov/L/GDocs.cfm>.

Contact Information:

Please contact the Department of Conservation and Recreation's Division of Dam Safety and Floodplain Management at dam@dcr.virginia.gov or by calling 804-371-6095 with any questions regarding the application of this guidance.

Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the Department of Conservation and Recreation in administering the Dam Safety Program on behalf of the Virginia Soil and Water Conservation Board. This guidance provides a general interpretation of the applicable Code and Regulations but is not meant to be exhaustive in nature. Each situation may differ and may require additional interpretation of the Dam Safety Act and attendant regulations. This guidance is not intended and cannot be relied on to create any rights, substantive or procedural, on the part of any person or entity.

Impounding Structure Hazard Potential Classifications Procedures

I. Background:

Section 4VAC50-20-40 of the Impounding Structure Regulations stipulates that impounding structures shall be classified in one of three hazard classifications. This guidance document shall explain the process by which a determination is made regarding the proper hazard classification of an owner's dam.

Guidance Documents that are used in conjunction with this guidance document include:

- Guidance Document on Roadways on or Below Impounding Structures
- Guidance Document on Dam Break Inundation Zone Modeling and Mapping Procedures
- Guidance Document on New Probable Maximum Precipitation (PMP) Implementation

II. Definitions (pursuant to § 10.1-604, 4VAC50-20-30, and 4VAC50-20-50):

"Dam break inundation zone" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam.

"Normal or typical water surface elevation" means the water surface elevation at the crest of the lowest ungated outlet from the impoundment or the elevation of the normal pool of the impoundment if different than the water surface elevation at the crest of the lowest ungated outlet. For calculating sunny day failures for flood control impounding structures, stormwater detention impounding structures, and related facilities designed to hold back volumes of water for slow release, the normal or typical water surface elevation shall be measured at the crest of the auxiliary or emergency spillway.

"PMF" means the Probable Maximum Flood is the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF shall be calculated from the probable maximum precipitation (PMP) derived from the Probable Maximum Precipitation Study for Virginia (and associated PMP Evaluation Tool and Database) (November 2015). The owner's engineer must develop PMF hydrographs for 6-, 12-, and 24-hour durations. The hydrograph that creates the largest peak outflow is to be used to determine capacity for non-failure and failure analysis. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area

"Sunny day dam failure" means the failure of an impounding structure with the initial water level at the normal reservoir level, usually at the lowest ungated principal spillway elevation or the typical operating water level.

III. Authority:

The Dam Safety Act (§ 10.1-604 et seq.) in the *Code of Virginia* contains the following authorities applicable to this guidance:

§ 10.1-605. Promulgation of regulations by the Board.

The Board shall promulgate regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated.

Appendix 1 contains the *Code of Virginia* authorities (extended) applicable to this guidance and Appendix 2 contains the *Impounding Structure Regulations* authorities applicable to this guidance. These include:

- § 10.1-605. Promulgation of regulations by the Board.
- 4VAC50-20-40. Hazard potential classifications of impounding structures.
- 4VAC50-20-50. Performance Standards Required for Impounding Structures
- 4VAC50-20-52. Incremental Damage Analysis.
- 4VAC50-20-54. Dam break inundation zone mapping.

IV. Discussion and Interpretation:

Hazard Class is first determined using the Standard Hazard Class determination from section 4VAC50-20-40 using the inundation zones only. A second method using incremental analysis from ACER-11 may be used as a subsequent option to refine the Hazard Class determination after the Standard Hazard Class determination is completed. We will discuss the Standard Hazard Class determination method starting on page 4, and then discuss the ACER-11 Hazard Class determination method starting on page 6.

Hazard Potential Classifications for Determining the Hazard Class of a Dam

In accordance with 4VAC50-20-40, three hazard potential classifications exist for regulated impounding structures: Low, Significant and High. As the classification increases, likewise the potential hazard to human life and/or economic damage increases.

High Hazard Class dams are impounding structures where failure of the dam will cause probable loss of life or serious economic damage.

"Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high volume roadways.

A dam break inundation zone map that depicts inundation impacts on any of the items listed above justifies a High Hazard Classification.

Significant Hazard Class dams are impounding structures where failure may cause the loss of life or appreciable economic damage.

"May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways. [NOTE: Low volume roadways are discussed in greater detail in the Board's Guidance Document on Roadways On or Below Impounding Structures.]

A dam break inundation zone map that depicts inundation impacts on any of the items listed above justifies, at a minimum, a Significant Hazard Class.

Low Hazard Class dams are impounding structures where failure would result in no expected loss of life and would cause no more than minimal economic damage.

"No expected loss of life" means no loss of life is anticipated.

A dam break inundation zone map that depicts inundation impacts on properties other than those owned by the dam owner justifies, at a minimum, a Low Hazard Class.

Engineering analyses performed by the dam owner's engineer to evaluate a sunny-day dam failure and review the complete range of storm event failures (50-year flood to the full PMF)

may result in no impacts other than to non-productive lands within the floodplain. Such results may be used when there is uncertainty by an owner's engineer whether to certify that the impounding structure is a low special hazard potential impounding structure in accordance with 4VAC50-20-51 as its failure will cause no expected loss of human life and no economic damage to any property except property owned by the impounding structure owner.

It should be understood that with this Hazard Class determination process, all possible situations with impacted structures/facilities cannot be defined in this procedure. Judgment and common sense should be applied in making any decision on classifications. No allowance for evacuation or other emergency actions for the public can be considered in determining the Hazard Class, because emergency procedures are not a substitute for appropriate design, construction, and maintenance of impounding structures. Consultation with DCR Dam Safety staff by the dam owner and the dam owner's consulting professional engineer is highly recommended in unusual situations that might vary from this procedure.

Computer modeling of flood routings is not an exact science, therefore maintaining a conservative procedure in determining the Hazard Class of an impounding structure is critical in protecting public safety. The purpose of establishing the Hazard Class is to determine required design criteria and establishes the frequency of periodic inspections by the dam owner's professional engineer.

Procedure for Determining the Standard Hazard Class of a Dam

The Standard Hazard Class determination process is a straightforward procedure to determine the potential impacts downstream of a regulated impounding structure, through conducting a dam break inundation zone analysis and developing the required dam break inundation zone map(s). The procedure uses the inundation map zones only to determine the Hazard Class by evaluating whether a person or structure is fully or partially located within the dam break inundation zone. All structures fully or partially within an inundation zone must be included as an impacted structure for hazard class determination using this procedure. The Standard Hazard Class does not use an incremental analysis in the determination of the hazard classification.

Step 1: Run an approved computer model to simulate a sunny day dam break to determine potential inundation downstream of the dam.

Are there any residences, primary roadways, major utilities, etc. located fully or partially within the inundation zone?

Yes: Assign High Hazard Class, proceed to:

- a. 4VAC50-20-50 indicates the established Spillway Design Flood (SDF) is the PMF (.90 PMP for existing structures), the owner's engineer must run approved computer models to simulate the full PMF with a dam break and then without a dam break.
- b. The owner's engineer must complete a Dam Break Inundation Zone Map that must include inundation lines that represent downstream flooding for a sunny day dam break, a dam break during a full PMF and full PMF without a dam break.

No: Hazard Class unknown, proceed to Step 2.

Step 2: Run an approved computer model to simulate a dam break during the Probable Maximum Flood to determine potential inundation downstream of the dam.

Are there any impacted residences, primary roadways, major utilities, etc. located fully or partially within the inundation zone?

Yes: Assign High Hazard Class, proceed to:

- a. 4VAC50-20-50 indicates that the established SDF is the PMF, the owner's Engineer must run an approved computer model to simulate the full PMF without a dam break.
- b. The owner's engineer must complete a Dam Break Inundation Zone Map that must include inundation lines that represent downstream flooding for a sunny day dam break, a dam break during a full PMF and full PMF without a dam break.

No: Hazard Class unknown, proceed to Step 3:

Step 3: Are there any secondary roadways (with greater than 400 average annual daily trips per day), nonresidential structures or utilities etc. within the Probable Maximum Flood dam break inundation zone or the sunny day dam break inundation zone?

Yes: Assign Significant Hazard Class, proceed to:

- a. 4VAC50-20-50 indicates the established SDF is the ½ PMF, the owner's engineer must run an approved computer model to simulate the ½ PMF without a dam break.
- b. The owner's engineer must complete a Dam Break Inundation Zone Map that must include inundation lines that represent downstream flooding for a sunny day dam break, a dam break during a full PMF, a dam break during a ½ PMF and ½ PMF without a dam break. In the rare circumstances where the ½ PMF dam break inundates structures not inundated by the full PMF dam break (where the convergence is further downstream than the PMF convergence), the newly inundated structures must be included in the Hazard Class determination which may result in a higher hazard determination.

No: Assign Low Hazard Class, proceed to:

- a. The owner's engineer must run approved computer models to simulate the 100-Year Flood with a dam break and the 100-Year Flood without a dam break.
- b. Complete a Dam Break Inundation Zone Map that must include inundation lines that represent downstream flooding for a sunny day dam break, a dam break during the 100-Year Flood and the 100-Year Flood without a dam break and the full PMF with a dam break. In the rare circumstances where the 100-Year Flood dam break inundates structures not inundated by the full PMF dam break (where

the convergence is further downstream than the PMF convergence), the newly inundated structures must be included in the Hazard Class determination which may result in a higher hazard determination.

Note: If the dam owner decides to authorize his consulting professional engineer to perform a spillway design flood Incremental Damage Analysis (IDA) and the IDA results in the reduction in the spillway design flood, the final Dam Break Inundation Zone Map must contain the inundation zones associated with the dam failure during a PMF, a sunny day dam break, the spillway design flood with a dam break, and the spillway design flood without a dam break. At no time will a spillway design flood be allowed that would be less than that listed as the Minimum Threshold for Incremental Damage Analysis in Table 1 of the Virginia Impounding Structure Regulations.

The dam owner may also decide to authorize his consulting professional engineer to perform a Hazard Class incremental analysis using United States Department of Interior, Bureau of Reclamation's ACER Technical Memorandum No. 11, 1988 (ACER-11) under 4VAC50-20-52.A.

Procedure for Determining the ACER-11 Hazard Class of a Dam

The following steps outline the ACER-11 Analysis for Hazard Class determination used when the dam owner wishes to refine the hazard class after completing the Standard Hazard Class procedure above.

If the Dam Owner wishes to refine the Hazard Class determination they may have their engineer perform an incremental Hazard Class determination using Section III of the United States Department of Interior, Bureau of Reclamation's Technical Memorandum No. 11, 1988 (ACER-11) in accordance with 4VAC50-20-52.A. This is an optional procedure and is not required but is presented as an additional refinement to the Hazard Class determination.

All four (4) steps must be performed in sequence to determine Hazard Class using ACER-11. This procedure must be performed on each structure individually. ACER-11 will determine if an individual structure is “impacted” (or not) using the Danger Zone graphs on pages 25 to page 32 of ACER-11. The hazard class of an “impacted” structure is determined by the Regulation Section 50-20-40 definitions of Hazard Potential Class. Please note for Virginia Dam Safety the flood depth for a dwelling structure is taken from the lowest elevation the structure/foundation touches grade – **not** finished floor elevation. Structures that are not considered “impacted” under ACER-11 may be removed from the Hazard Class determination.

ACER-11 Step 1: Perform the Sunny Day Failure Analysis

Use the appropriate danger zone graph to show if the hazard is in the low danger zone or the engineer’s judgment is allowed in the judgment zone. PE judgment of low danger of impacts in the” judgment zone” must be justified in a written explanation signed and sealed by the PE.

For step 1 run the Sunny Day Failure (if this step’s hazard potential is High then the dam is High Hazard).

ACER-11 Step 2: Perform the Probable Maximum Flood Failure Analysis

If the danger zone obtained from the first step is less than high then determine the effects of increasing the loading conditions to the PMF dam break flood during the peak PMF outflow flood on the downstream flooding. The intent is to evaluate the worst case scenario which accounts for the PMF. If the danger zone does not increase under these assumptions then use the Sunny Day Failure for the Hazard Potential Class.

For step 2 run the PMF failure during peak PMF outflow.

ACER-11 Step 3: Perform the Probable Maximum Flood without the dam in place

If for any reason the hazard class with no dam existing is less than the PMF with failure then the hazard class of the PMF with failure is used. This step separates the flooding due to dam failure from that due to a natural flood. The reasoning here is that the incremental effects of the dam failure raise the hazard classification above that of the PMF flooding alone. Please use the danger zone graph to show which structures are already in the high danger zone during natural flooding.

For step 3 run the PMF **without** the dam in the river basin and compare it to the peak PMF dam failure.

ACER-11 Step 4: Perform the Incipient Failure for each structure.

Each structure eliminated from the flooding hazard classification must show the incipient flooding with and without failure to see if there is an incremental increase in hazard. The incipient flood is the flood event that just reaches the structure but does not flood the structure (without dam failure). Evaluate a dam failure at this flood event and compare the resultant inundation flooding to the danger zone graph. This must be done for each structure that is eliminated from the hazard classification (i.e. determined as not impacted from dam failure).

For step 4 run the incipient flood with failure for **each structure**.

Should this process result in a lower hazard classification than the Standard Hazard Classification, the lower hazard classification may be used. The highest hazard class determined by any of the above ACER-11 steps prevails as the hazard potential class. Please submit spreadsheets and maps that show each structure the engineer has eliminated from the flooding hazard classification. The spreadsheets must show the total flood depth and velocity for each structure and the danger zone from the ACER 11 danger zone graphs. Inundation maps labeling each structure should accompany spreadsheets. ACER-11 danger zone level determines level of impact not hazard class. Use Regulation Section 50-20-40 for Hazard Potential class of impacted structures.

Note: the danger zone graph that shows the highest likely hazard should be used. Roads and structures in areas known for pedestrian traffic such as school zones, sports fields, play grounds or outdoor worksites should also use the pedestrian charts to determine danger zone level. A possible example is an elementary school where the structure and adjacent roadway are within

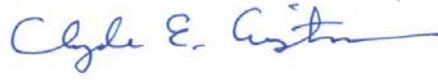
the low danger zone using the “passenger vehicle” and “home” graphs but using the “children” graph shows it to be in the high danger zone. The children’s rating should be used to determine hazard class and the area would be considered impacted by the dam failure.

V. Adoption, Amendments, and Repeal:

This document will remain in effect until rescinded or superseded.



Daphne W. Jamison
Board Chair



Clyde E. Cristman
Department Director

Appendix 1

Applicable *Code of Virginia* Authorities.

The *Code of Virginia* contains the following authorities applicable to this Guidance:

§ 10.1-605. Promulgation of regulations by the Board; guidance document.

A. The Board shall adopt regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated. Dam safety regulations promulgated by the State Water Control Board shall remain in full force until amended in accordance with applicable procedures.

B. The Board's Impounding Structure Regulations shall not require any impounding structure in existence or under a construction permit prior to July 1, 2010, that is currently classified as high hazard, or is subsequently found to be high hazard through reclassification, to upgrade its spillway to pass a rainfall event greater than the maximum recorded within the Commonwealth, which shall be deemed to be 90 percent of the probable maximum precipitation.

1. Such an impounding structure shall be determined to be in compliance with the spillway requirements of the regulations provided that (i) the impounding structure will pass two-thirds of the reduced probable maximum precipitation requirement described in this subsection and (ii) the dam owner certifies annually and by January 15 that such impounding structure meets each of the following conditions:

- a. The owner has a current emergency action plan that is approved by the Board and that is developed and updated in accordance with the regulations;
- b. The owner has exercised the emergency action plan in accordance with the regulations and conducts a table-top exercise at least once every two years;
- c. The Department has verification that both the local organization for emergency management and the Virginia Department of Emergency Management have on file current emergency action plans and updates for the impounding structure;
- d. That conditions at the impounding structure are monitored on a daily basis and as dictated by the emergency action plan;
- e. The impounding structure is inspected at least annually by a professional engineer and all observed deficiencies are addressed within 120 days of such inspection;
- f. The owner has a dam break inundation zone map developed in accordance with the regulations that is acceptable to the Department;
- g. The owner is insured in an amount that will substantially cover the costs of downstream property losses to others that may result from a dam failure; and
- h. The owner shall post the dam's emergency action plan on his website, or upon the request of the owner, the Department or another state agency responsible for providing emergency management services to citizens agrees to post the plan on its website. If the Department or another state agency agrees to post the plan on its website, the owner shall provide the plan in a format suitable for posting.

2. A dam owner who meets the conditions of subdivisions 1 a through 1 h, but has not provided record drawings to the Department for his impounding structure, shall submit a complete record report developed in accordance with the construction permit requirements of the Impounding Structure Regulations, excluding the required submittal of the record drawings.

3. A dam owner who fails to submit certifications required by subdivisions 1 a through 1 h in a timely fashion shall not enjoy the presumption that such impounding structure is deemed to be

in compliance with the spillway requirements of the Board's Impounding Structure Regulations (4VAC50-20).

4. Any dam owner who has submitted the certifications required by subdivisions 1 a through 1 h shall make (i) such certifications, (ii) the emergency action plan required by subdivision 1 a, and (iii) the certificate of insurance required by subdivision 1 g available, upon request and within five business days, to any person. A dam owner may comply with the requirements of this subdivision by providing the same information on a website and directing the requestor to such website. A dam owner who fails to comply with this subdivision shall be subject to a civil penalty pursuant to § 10.1-613.2.

C. The Board's regulations shall establish an incremental damage analysis procedure that permits the spillway design flood requirement for an impounding structure to be reduced to the level at which dam failure shall not significantly increase downstream hazard to life or property, provided that the spillway design flood requirement shall not be reduced to below the 100-year flood event for high or significant hazard impounding structures, or to below the 50-year flood event for low hazard potential impounding structures.

D. The Board shall consider the impact of limited-use or private roadways with low traffic volume and low public safety risk that are downstream from or across an impounding structure in the determination of the hazard potential classification of an impounding structure.

Appendix 2

Applicable *Impounding Structure Regulations* Authorities.

The *Impounding Structure Regulations* contains the following authorities applicable to this Guidance.

4VAC50-20-40. Hazard Potential Classifications of Impounding Structures.

A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways, except those having an AADT volume of 400 vehicles or less in accordance with 4VAC50-20-45.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways, except those having an AADT volume of 400 vehicles or less in accordance with 4VAC50-20-45.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated.

C. To support the appropriate hazard potential classification, dam break analysis shall be conducted by the owner's engineer or the department in accordance with one of the following alternatives and utilizing procedures set out in 4VAC50-20-54.

1. The owner of an impounding structure that does not currently hold a regular or conditional certificate from the board, or the owner of an impounding structure that is already under certificate but the owner believes that a condition has changed downstream of the impounding structure that may reduce its hazard potential classification, may request in writing that the department conduct a simplified dam break inundation zone analysis to determine whether the impounding structure has a low hazard potential classification. The owner shall pay a fee to the department in accordance with 4VAC50-20-395 for conducting each requested analysis. The

department shall address requests in the order received and shall strive to complete analysis within 90 days; or

2. The owner may propose a hazard potential classification that shall be subject to approval by the board. To support the proposed hazard potential classification, an analysis shall be conducted by the owner's engineer and submitted to the department. The hazard potential classification shall be certified by the owner.

D. Findings of the analysis conducted pursuant to subsection C of this section shall result in one of the following actions:

1. For findings by the department resulting from analyses conducted in accordance with subdivision C 1 of this section:

a. If the department finds that the impounding structure appears to have a low hazard potential classification, the owner may be eligible for general permit coverage in accordance with 4VAC50-20-103.

b. If the department finds that the impounding structure appears to have a high or significant hazard potential classification, the owner's engineer shall provide further analysis in accordance with the procedures set out in 4VAC50-20-54 and this chapter. The owner may be eligible for grant assistance from the Dam Safety, Flood Prevention and Protection Assistance Fund in accordance with Article 1.2 (§ 10.1-603.16 et seq.) of Chapter 6 of Title 10.1 of the Code of Virginia.

2. For findings by the owner's engineer resulting from analyses conducted in accordance with subdivision C 2 of this section:

a. If the engineer finds that the impounding structure has a low hazard potential classification, the owner may be eligible for general permit coverage in accordance with 4VAC50-20-103; or

b. If the engineer finds that the impounding structure appears to have a high or significant hazard potential classification, then the owner shall comply with the applicable certification requirements set out in this chapter.

E. An incremental damage analysis in accordance with 4VAC50-20-52 may be utilized as part of a hazard potential classification by the owner's engineer.

F. Impounding structures shall be subject to reclassification by the board as necessary.

4VAC50-20-50. Performance Standards Required for Impounding Structures.

A. In accordance with the definitions provided by § 10.1-604 of the Code of Virginia and 4VAC50-20-30, an impounding structure shall be regulated if the impounding structure is 25 feet or greater in height and creates a maximum impounding capacity of 15 acre-feet or greater, or the impounding structure is six feet or greater in height and creates a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia. Impounding structures exempted from this chapter are those that are:

1. Licensed by the State Corporation Commission that are subject to a safety inspection program;

2. Owned or licensed by the United States government;

3. Operated primarily for agricultural purposes that are less than 25 feet in height or that create a maximum impoundment capacity smaller than 100 acre-feet;

4. Water or silt-retaining dams approved pursuant to § 45.1-222 or 45.1-225.1 of the Code of Virginia; or

5. Obstructions in a canal used to raise or lower water.

Impounding structures of regulated size and not exempted shall be constructed, operated and maintained such that they perform in accordance with their design and purpose throughout the life of the project. For impounding structures, the spillway capacity shall perform at a minimum to safely pass the appropriate spillway design flood as determined in Table 1. For the purposes of utilizing Table 1, Hazard Potential Classification shall be determined in accordance with 4VAC50-20-40.

TABLE 1 Impounding Structure Regulations			
Applicable to all impounding structures that are 25 feet or greater in height and that create a maximum impounding capacity of 15 acre-feet or greater, and to all impounding structures that are six feet or greater in height and that create a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia.			
Hazard Potential Class of Dam	Spillway Design Flood (SDF) ^B for New Construction ^F	Spillway Design Flood (SDF) ^B for Existing Impounding Structures ^{F, G}	Minimum Threshold for Incremental Damage Analysis
High	PMF ^C	0.9 PMP ^H	100-YR ^D
Significant	.50 PMF	.50 PMF	100-YR ^D
Low	100-YR ^D	100-YR ^D	50-YR ^E

B. The spillway design flood (SDF) represents the largest flood that need be considered in the evaluation of the performance for a given project. The impounding structure shall perform so as to safely pass the appropriate SDF. Reductions in the established SDF may be evaluated through the use of incremental damage analysis pursuant to 4VAC50-20-52. The SDF established for an impounding structure shall not be less than those standards established elsewhere by state law or regulations, including but not limited to the Virginia Stormwater Management Program (VSMP) Regulation (9VAC25-870). Due to potential for future development in the dam break inundation zone that would necessitate higher spillway design flood standards or other considerations, owners may find it advisable to consider a higher spillway design flood standard than is required.

C. PMF: Probable Maximum Flood is the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF shall be calculated from the probable maximum precipitation (PMP) derived from the Probable Maximum Precipitation Study for Virginia (and associated PMP Evaluation Tool and Database) (November 2015). The owner's engineer must develop PMF hydrographs for 6-, 12-, and 24-hour durations. The hydrograph that creates the largest peak outflow is to be used to determine capacity for nonfailure and failure analysis. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

D. 100-Yr: 100-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 100 years. It may also be expressed as an exceedance probability with a 1.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

E. 50-Yr: 50-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 50 years. It may also be expressed as an exceedance probability with a

2.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

F. For the purposes of Table 1 "Existing impounding structure" and "New construction" are defined in 4VAC50-20-30.

G. An existing impounding structure as defined in 4VAC50-20-30, that is currently classified as high hazard, or is subsequently found to be high hazard through reclassification, shall only be required to pass the flood resulting from 0.6 PMP instead of the flood resulting from the 0.9 PMP SDF if the dam owner meets the requirements set out in 4VAC50-20-53.

H. PMP: Probable maximum precipitation means the theoretically greatest depth of precipitation for a given duration that is meteorologically possible over a given size storm area at a particular geographical location at a particular time of year with no allowance made for future long-term climatic trends. In practice, this is derived by storm transposition and moisture adjustment to observed storm patterns. In Virginia, the 0.9 PMP is meant to characterize the maximum recorded rainfall event within the Commonwealth.

4VAC50-20-52. Incremental Damage Analysis.

A. The proposed potential hazard classification for an impounding structure may be lowered based on the results of an incremental damage analysis utilizing one of the following methodologies:

1. Section III of the United States Department of Interior, Bureau of Reclamation's ACER Technical Memorandum No. 11, 1988. An impact shall be deemed to occur where there are one or more lives in jeopardy as a result of a dam failure; or

2. An approach to determining hazard classification found in any document that is on the list of acceptable references set out in 4VAC50-20-320. The owner's engineer shall reference the methodology utilized in the submittal to the department.

B. The proposed spillway design flood for the impounding structure may be lowered based on the results of an incremental damage analysis. Once the owner's engineer has determined the required spillway design flood through application of Table 1, further analysis may be performed to evaluate the limiting flood condition for incremental damages. Site-specific conditions should be recognized and considered. In no situation shall the allowable reduced level be less than the level at which the incremental increase in water surface elevation downstream due to failure of an impounding structure is no longer considered to present an additional downstream threat. This engineering analysis will need to present water surface elevations at each structure that may be impacted downstream of the dam. An additional downstream threat to persons or property is presumed to exist when water depths exceed two feet or when the product of water depth (in feet) and flow velocity (in feet per second) is greater than seven.

The spillway design flood shall also not be reduced below the minimum threshold values as determined by Table 1.

C. The proposed potential hazard classification for the impounding structure and the required spillway design flood shall be subject to reclassification by the board as necessary to reflect the incremental damage assessment, changed conditions at the impounding structure, and changed conditions in the dam break inundation zone.

4VAC50-20-54. Dam Break Inundation Zone Mapping.

A. Dam break inundation zone maps and analyses shall be provided to the department, except as provided for in 4VAC50-20-51, to meet the requirements set out in 4VAC50-20-40, 4VAC50-

20-175, and 4VAC50-20-177, as applicable. In accordance with subsection G of this section, a simplified dam break inundation zone map and analysis may be completed by the department and shall be provided to the impounding structure's owner to assist such owner in complying with the requirements of this chapter. All analyses shall be completed in accordance with 4VAC50-20-20 D.

B. The location of the end of the inundation mapping should be indicated where the water surface elevation of the dam break inundation zone and the water surface elevation of the spillway design flood during an impounding structure nonfailure event converge to within one foot of each other. The inundation maps shall be supplemented with water surface profiles showing the peak water surface elevation prior to failure and the peak water surface elevation after failure.

C. All inundation zone map(s) shall be signed and sealed by a licensed professional engineer.

D. Present and planned land-use for which a development plan has been officially approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered in determining the classification.

E. For determining the hazard potential classification, an analysis including, but not limited to, those hazards created by flood and nonflood dam failures shall be considered. At a minimum, the following shall be provided to the department:

1. A sunny day dam break analysis utilizing the volume retained at the normal or typical water surface elevation of the impounding structure;
2. A dam break analysis utilizing the spillway design flood with a dam failure;
3. An analysis utilizing the spillway design flood without a dam failure; and
4. A dam break analysis utilizing the probable maximum flood with a dam failure.

F. To meet the Emergency Action Plan requirements set out in 4VAC50-20-175 and the Emergency Preparedness Plan requirements set out in 4VAC50-20-177, all owners of impounding structures shall provide dam break inundation zone map(s) representing the impacts that would occur with both a sunny day dam failure and a probable maximum flood with a dam failure.

1. The map(s) shall be developed at a scale sufficient to graphically display downstream inhabited areas and structures, roads, public utilities that may be affected, and other pertinent structures within the identified inundation area. In coordination with the local organization for emergency management, a list of downstream inundation zone property owners and occupants, including telephone numbers may be plotted on the map or may be provided with the map for reference during an emergency.

2. Each map shall include the following statement: "The information contained in this map is prepared for use in notification of downstream property owners by emergency management personnel."

Should the department prepare a dam break inundation zone map and analysis in response to a request received pursuant to 4VAC50-20-40 C, the owner shall utilize this map to prepare a plan in accordance with this subsection.

G. Upon receipt of a written request in accordance with 4VAC50-20-40 C and receipt of a payment in accordance with 4VAC50-20-395, the department shall conduct a simplified dam break inundation zone analysis. In conducting the analysis, a model acceptable to the department shall be utilized. The analysis shall result in maps produced as Geographic Information System shape files for viewing and analyzing and shall meet the other analysis criteria of this section.

Upon completion of the analysis, the department shall issue a letter to the owner communicating the results of the analysis including the dam break inundation zone map, stipulating the department's finding regarding hazard potential classification based on the information available to the department, and explaining what the owner needs to do procedurally with this information to be compliant with the requirements of the Dam Safety Act (§ 10.1-604 et seq.) and this chapter.